Phaesun
stand-alone solar solutions

Documentation

PN-AP

Solar pumping inverter

Installation and user manual

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1. Safety recommendations

1.1. Compulsory safety instructions

General danger

When installing a solar-powered pumping system, it is vital to adhere to standard safety recommendations and working practices related to international standards (electrical and handling)

Risk of electric shock

High voltage and / or current. Do not touch connectors or terminals without using adequate protective insulation. Use insulated tools. Remove all items liable to generate a short circuit (jewellery, etc.)

A fire extinguisher must be kept close by (e.g. in the vehicle)

In case of fire, use a CO_2 or foam extinguisher. Spray on to the fire from a distance of more than 50 cm

1.2. What NOT to do

Do not try to extinguish a fire with water

If the inverter or any other electrical device catches fire, do not try to extinguish it with water, as you will risk being electrocuted.

Access prohibited unless authorized

Access to the generator assembly area is strictly forbidden to unauthorised individuals.

Do not approach sources of heat or ignition near the inverter

Gases given off may well catch fire.

Strictly no smoking

This might damage electrical apparatus.

1.3. Safety protection for installation, handling and maintenance

The photovoltaic panels must be covered when working on any electrical part of the installation (cloths, cardboard packaging used for the modules, carpets, etc.)

Helps to avoid electrocution. Be careful not to scratch the modules!

Protective goggles must be worn

An electric arc may cause eye injuries.

Suitable footwear must be worn

Safety shoes must be worn whenever carrying out a handling operation.

Protective clothing recommended

Clothing made with synthetic materials should not be worn. Wear cotton clothing that covers the whole body.

1.4. Responsible behavior

1.4.1. Safety training

Out of a concern to prevent accidents, we recommend that all staff receive suitable training related to the contents of this document before installing or working on the system concerned.

1.4.2. Handling structures

Any installation or other work on structures making up the photovoltaic field should be avoided during high winds.

Particular attention should be paid to handling parts of the structure, especially when working at height on high structures. We strongly recommend that a safety helmet is worn.

For more detailed information, please refer to the corresponding chapter on structure assembly.

1.4.3. Working on photovoltaic modules

When altering the wiring on modules, you are strongly advised to cover all the modules in the sub-field concerned [e.g. with the modules packaging]. The current generated by a single module may be enough to kill beyond a certain voltage (50 Volts of continuous current). It is therefore vital to guard against any electric shock.

1.4.4. Electrical wiring

Poor quality wiring may lead to electrical accidents. All electrical wiring must be carried out in compliance with standard NFC15-100 by qualified technicians or a suitably trained individual.

2. Presentation and technical features

2.1. Application

Photovoltaic pumping helps meeting the vital water supply needs of populations and to solve the problems of providing energy for agricultural and trade uses in areas where there is no reliable electrical supply.

Prior to from the pumping system, the photovoltaic generator produces continuous current that has to be converted into alternating current to supply the motor-pump further down the line. In a system that works on sunlight, i.e. without a battery, motor speed has to be adjusted to the light intensity available at any given moment.

This function is carried out by the inverter.

2.2. Presentation of the PN-AP inverter

The PN-AP converter is a three-phase, variable frequency inverter for use on standard pumps (3 x 230V_{AC}).

The product is specially designed to meet the specific conditions involved in solar-powered pumping and takes account of all the requirements. It offers an effective, compact solution to meet the special demands of this application.

2.3. The main features of the PN-AP

2.3.1. Managing the start-up phase after the night

As the only energy source is the photovoltaic generator, the PN-AP is designed to start up gradually in the morning, ensuring that the energy available is sufficient.

2.3.2. Managing phases where the power available is not sufficient

In some cases (evening, cloud passing over, shadow), the energy source falls rapidly and, sometimes, the power available is not sufficient to operate the pump properly. The PN-AP inverter is designed to manage these events, thus avoiding the pump having to start up repeatedly, and power supply at too low a frequency, causing damaging bubbling in the pump.

2.3.3. Optimizing available input power (MPPT)

Phaesun has designed and developed an innovative procedure for Maximum Power Point Tracking (MPPT).

MPPT is used to get the best from the input power available. The power supplied by the solar panels will depend on the level of sunshine and the temperature of the solar cells.

To maximise the effectiveness of the energy conversion device and therefore get the best use of the solar panels, it needs to be permanently working as near as possible to the point where the power, according to the voltage in the generator, is at its maximum.

2.4. Technical features

PN-AP pumping inverter	Unit	Specifications / details
Input		
Nominal input voltage	[V_{DC}]	325
Over voltage	[V_{DC}]	450
Acceptable input voltage without degradation	[V_{DC}]	500
Operating input range	[V_{DC}]	200 à 360
Output		
Nominal voltage per phase	[V_{AC}]	230
Maximum output frequency	[Hz]	53
Minimum output frequency	[Hz]	6
Nominal maximum power of the standard asynchronous motor	[kW]	5.5
Output efficiency	[%]	> 97
Main characteristics		
Operating temperatures	[°C]	-10 à 75
Relative humidity	[%]	95
Type of protection		IP55
Casing		Beige Anodized
Cover		Stainless steel
Tropicalized version		Yes

Table 1. General features of the PN-AP inverter

2.5. Safety features

The inverter contains a manually operated multipolar switch to provide load cut-off or shut down and safety cut-out. In addition, in position O, the lid may be opened.

A number of safety features are incorporated into our product to provide greater reliability. These include protection against:

- too high input voltage on the continuous bus,
- overload on the pump side (jamming),
- inversion of module polarity,
- inverter at too high a temperature,
- lack of water in the well,
- short-circuit on the pump side,
- full tank (combined with a tank fitted with a ballcock, optional),

2.6. Use and operation

2.6.1. Use

The various operating situations are shown by leds on the front of the inverter. These are explained below:

Figure 1. Front of the PN-AP inverter

2.6.2. Operating information

2.6.2.1. Green "Operation" / "Fonctionnement" led on

✓ State

Operating,

✓ System behavior

The inverter is operating normally. Operating parameters (DC input current, Motor frequency, etc.) may be accessed on the LCD display.

✓ Display messages

V entree : xxxV	V in : xxxV
I entree : xx.xA	I in : xx.xA
P entree : xxxxW	P in : xxxxW
Temp : xx°C	Temp : xx°C
Frequence: xxHz	Frequency: xxHz

Moves automatically from one to the other every 2 seconds

2.6.2.2. No led on

✓ State

The inverter is not operating but is not signalling any fault.

✓ Possible causes

Insufficient sunlight (night-time, clouds, mist, etc...)

✓ System behavior

If input power allows, the inverter attempts to start-up. If available input power is not sufficient to operate the pump properly (risk of damage to the motor due to lack of cooling), the inverter stops the operation and will make a new attempt every 2 minutes, until available power is sufficient.

✓ Display messages

P entree faible	Low input power

2.6.2.3. "Lack of water "/ "manque d'eau" led on

✓ State

The inverter is stopped.

✓ Possible causes

Lack of water in the well,
Bubbling in the pump,

✓ System behavior

The inverter stops and then tries to start up again 2 hours later. If the problem has not disappeared, the same procedure occurs again. If the two attempts are unsuccessful, the inverter switches itself off for the day.

The inverter automatically resets every night, which means that a test procedure can be carried out daily (detection plus 2 trials) to detect a return to normal operation.

✓ Display messages

Manque d'eau	Lack of water

2.6.2.4." Full Tank " / "Château d'eau plein" led on

✓ State

The inverter is stopped.

✓ Possible causes

The tank is full.

✓ System behavior

The level detector in the tank indicates that the tank is full via a switch (dry contact).

The inverter stops until the water level drops below the lower threshold. When the level drops below the lower threshold (change of state of TOR input), the inverter and pump start up again.

✓ Display messages

Reservoir plein	Full tank

2.6.2.5. "Overheating" / "surchauffe" led on

✓ State

The temperature of the system is too high. The operating cannot be assumed.

✓ Possible causes

Le PN-AP has been placed in the sun in poor conditions of ventilation,
The converter has been subjected to too high a load.
An internal problem (in particular, the power module has become separated from the heat sink) requires manual intervention.

✓ System behavior

The inverter switches into fault mode (ceases operation), then attempts to start up again 2 hours later. If the problem has not been resolved, the same procedure occurs as before. If the two attempts are unsuccessful, the inverter switches itself off for the day

The inverter is re-configured every night, which means that a test procedure can be carried out daily (detection plus 2 trials) to detect a return to normal operation.

✓ Display messages

Surchauffe	Overheating

2.6.2.6. "serious failure"/ "panne grave" led on

✓ State

Overload (current absorbed by the pump too high) or overvoltage (input voltage too high).

✓ Possible causes

Pump blocked,
Phase fault on the alternating current side,
Overload on the PV input,
Short-circuit on the pump side,
Poor wiring on the PV generator, causing too high a voltage.

✓ System behavior

Once it has detected a current or voltage higher than reference values, the inverter switches itself off. The inverter will only start up again :

- after manual action (engaging the switch: switching to OFF, waiting for 2 minutes, then switching to ON),
- on the following day, when the sun is shining again.

✓ Display messages

3. Installation

Important reminder:

The modules **must** be covered while they are being wired together (cloths, cardboard module packaging, carpet, etc.)

Operating voltages may be fatal!

Be careful not to scratch the modules!

3.1. Installation instructions

The inverter is installed beneath the photovoltaic generator, on two specially designed supports. To avoid subjecting the inverter to bad weather, it should be fixed under a panel, as shown in the diagram, and not on one of the structure's feet. The inverter should be mounted or dismantled before any wires are connected.

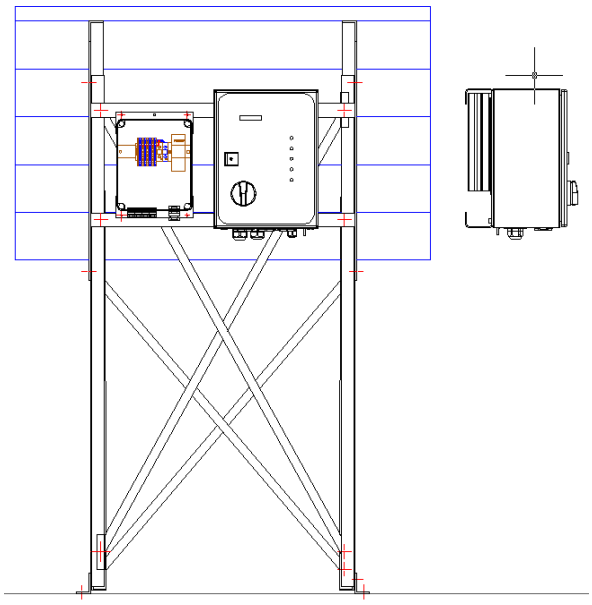

Figure 2. Installing the inverter at the back of the photovoltaic field nearest to the well

3.2. Wiring and commissioning

The safety recommendations set out at the beginning of this document must be followed in order to guard against electric shock. The system is powered by a generator operating at 500V (maximum) and under continuous current: direct accidental contact is fatal to humans.

Risk of fatal electric shock!

Follow the wiring instructions in chronological order. The installer should take particular care to ensure that the PCU / photovoltaic field connection is made at night only, with the modules covered.

3.2.1. Order of wiring :

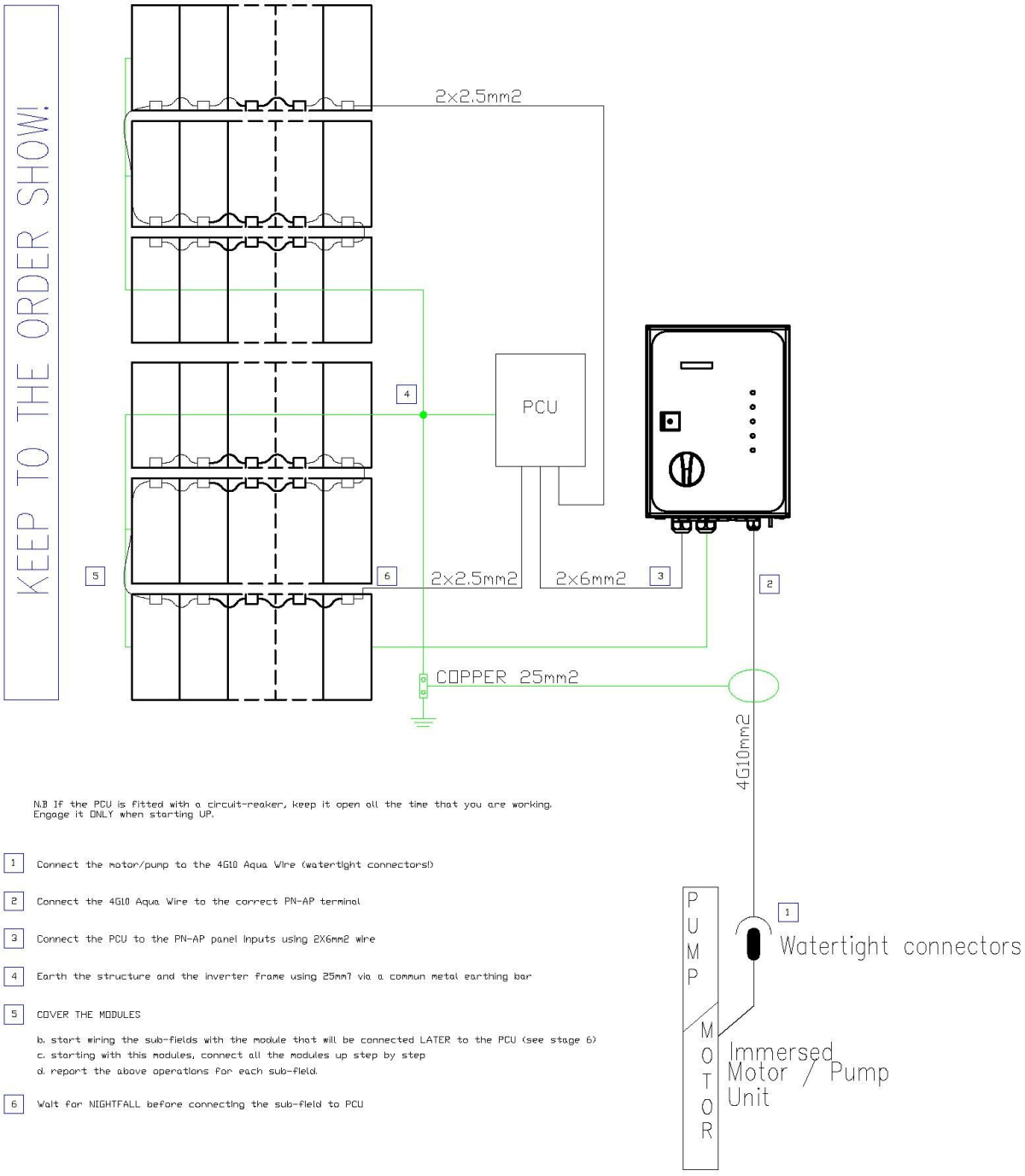
KEEP TO THE ORDER SHOW!
2x2.5mm2
PCU
4
5
6
2x2.5mm2
2x6mm2
3
2
COPPER 25mm2
4G10mm2
N.B If the PCU is fitted with a circuit-reaker, keep it open all the time that you are working.
Engage it ONLY when starting UP.
1 Connect the motor/pump to the 4G10 Aqua Wire (watertight connectors!)
2 Connect the 4G10 Aqua Wire to the correct PN-AP terminal
3 Connect the PCU to the PN-AP panel inputs using 2X6mm2 wire
4 Earth the structure and the inverter frame using 25mm7 via a commun metal earthing bar
5 COVER THE MODULES
b. start wiring the sub-fields with the module that will be connected LATER to the PCU (see stage 6)
c. starting with this modules, connect all the modules up step by step
d. report the above operations for each sub-field.
6 Wait for NIGHTFALL before connecting the sub-field to PCU
PUMP MOTOR
1
Watertight connectors
Immersed Motor / Pump Unit

Figure 3. General block diagram of the pumping system, order of wiring for the inverter

Refer to figures 4 and 5 for stages 1, 2 et 5.

3.2.2. Wiring the modules

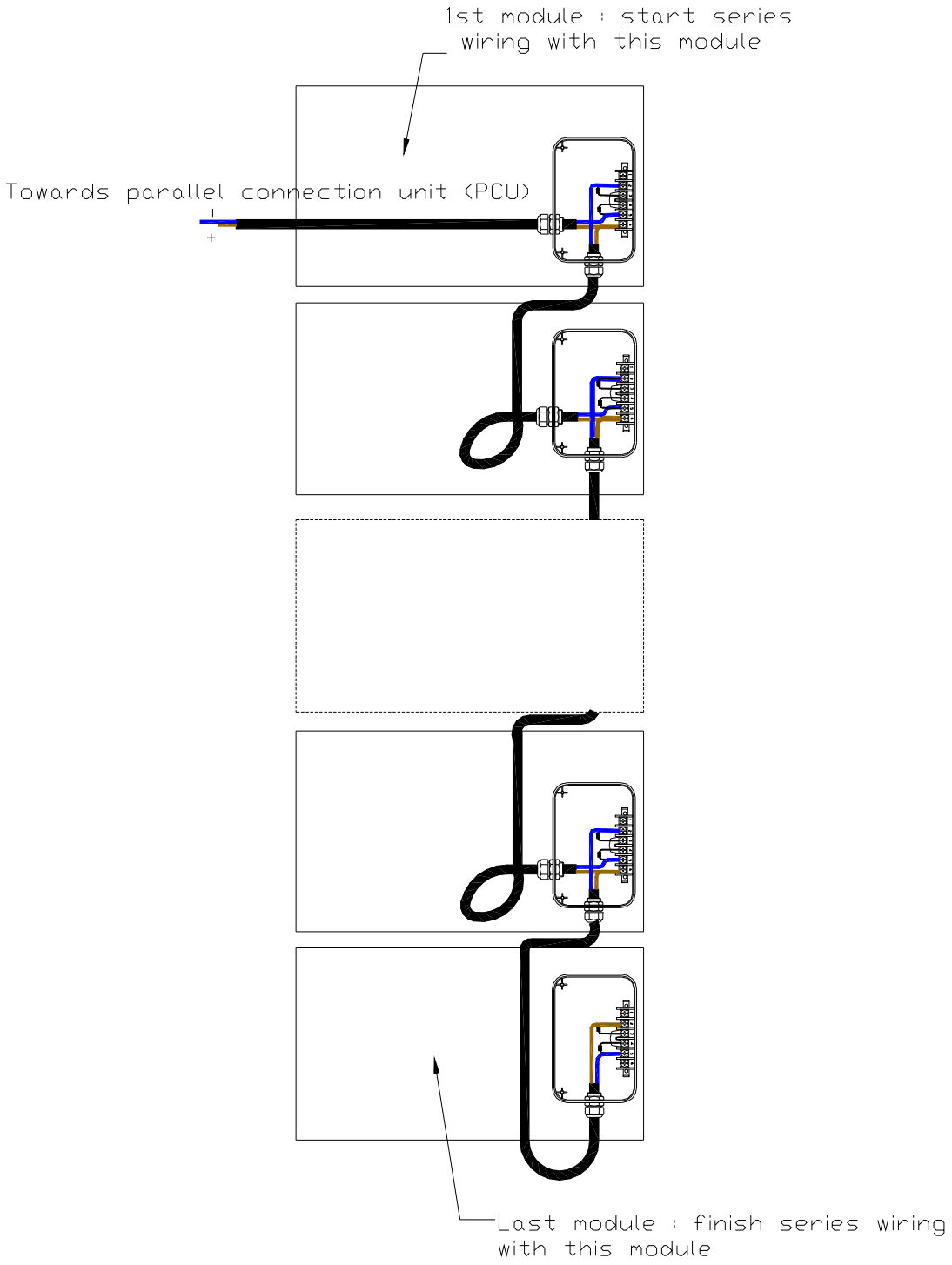
1st module : start series wiring with this module
Towards parallel connection unit (PCU)
-
+
Last module : finish series wiring with this module

Figure 4. Wiring modules in series

3.2.3. Electrical connection of the inverterr

Take great care whilst wiring; the generator supplies high-voltage current.

- ✓ Check that the switch on the front face is set at "O",
- ✓ Open the inverter casing to gain access to the connection terminals,
- ✓ Connect the motor supply wire to the three-phase inverter output (cf. diagram),
- ✓ Connect the earth to the external threaded rod provided,
- ✓ Check that the open-circuit voltage on the photovoltaic modules does not exceed 480 V_{DC},
- ✓ Connect the solar-powered generator to the PN-AP, ensuring that polarity is correct. The wires between the panels and the inverter should be as short as possible to avoid loss of voltage,

Warning : Connection should be from the inverter to the modules to avoid handling a live wire.

Where a system is fitted with the "full tank" option, the level regulator is connected to the terminal block in the inverter casing.

+

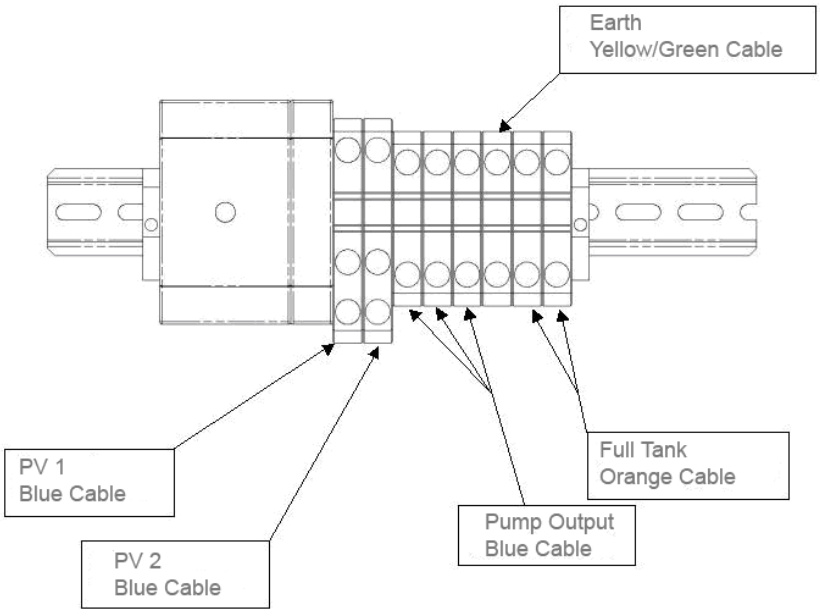

Figure 5. Terminal block diagram with wiring instructions

3.2.4. Commissioning

- ✓ Check that all connections have been made and that the pump is properly installed,
- ✓ Place the switch in position "|",

  The PN-AP converter does not require any adjustments. It will start up automatically. After the start-up period, it will turn the pump at a frequency proportional to the level of sunlight.

- ✓ Check the pump flow,
- ✓ Stop the system using the switch and **wait 2 minutes before handling to give the capacitors time to discharge,**

Risk of fatal electric shock!

- ✓ Reverse two motor cable wires on the terminal block,
- ✓ Repeat the commissioning procedure and check pump flow again. The better flow rate indicates the pump's correct rotation direction,

Once the whole procedure is completed, the system does not need to be handled again.

4. EMC and RoHS certifications

Phaesun stand-alone solar solutions

Ref: 320046A_CE_EN

CERTIFICATE OF CONFORMITY

This certifies that the following designed product:

PN-AP Pumping Inverter, referenced 295.D320.010

complies on the approximation of the laws of the Member States relating to electromagnetic compatibility with the requirements of the following EMC directives:

Directive	Title
2004/108/EC	Directive of the European Parliament and of the Council of the 15th December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
2006/95/EC	Directive of the European Parliament and of the Council of the 12th December 2006 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits

Assessment of compliance of the product with the requirements relating to electromagnetic compatibility was based on the following standards:

Standard	Edition	Title
IEC 60335-1	2003	Household and similar electrical appliances – Safety Part 1 : General requirements
IEC 61000-6-1	2007	Electromagnetic compatibility (EMC) – Part 6-1 : Generic standards – Immunity for residential, commercial and light-industrial environments
IEC 61000-6-3	2007	Electromagnetic compatibility (EMC) – Part 6-3 : Generic standards – Emission standard for residential, commercial and light-industrial environments

The certification is valid only in accordance with the test report No. R041-08-101228-AA/CHB and the product is manufactured in accordance with the test sample.

December, 2010

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Ref: 320046A_CE_EN

PB-FREE/REDUCTION OF HAZARDOUS SUBSTANCE (ROHS) CERTIFICATE OF COMPLIANCE

Based on information provided by our suppliers, this document certifies that the following manufactured product:

PN-AP Pumping Inverter, referenced 295.D320.010

is RoHS compliant*. The mentioned product complies with the requirements of the Directive 2002/95/EC of the European Parliament and of the Council of the 27th January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive).

RoHS

*RoHS compliant means that our suppliers have confirmed the compliance status of the relevant components for the mentioned product.

Confirmation of compliance status by our suppliers is either because the products do not contain any of the restricted substances referred to in Article 4(1) of the RoHS Directive at concentrations in excess of those permitted under the RoHS Directive or because removal of the restricted substances is not technically possible and their existence in the products at levels in excess of these concentrations is allowed as one of the particular applications listed in the Annex to the RoHS Directive.

December, 2010

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